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Road quality service levels and innovations to meet user expectations

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SUMMARY

New organization of the public service of the Czech Republic consisting in the decentralization of the executive power to regional level has had an impact on the organization of the road administration as well. The state represented by the Ministry of Transport and The Directorate of the Roads and Motorways (ŘSD) ensures the construction, repairs and maintenance of the motorways and roads of the 1st class including the network of European roads and motorways.

All the regions (13 + the capital of Prague) ensure construction, repairs and the maintenance of 2nd and 3rd class roads. These are financed by The State Fund of Transport Infrastructure that obtains the financial means partially from fuel tax, motorway toll (in the form of a label) and other fees. The significant part of the budget is formed by the means gained from the privatization. The budget is approved by the Parliament. Other means come from various European funds, EIB loans and the use of private means has also been agreed.

The priority for the construction of roads is to finish the motorway and the 1st class road network and interconnect them with the neighbour countries. Other goals are to solve the problems of economics development, higher density of infrastructure, traffic safety and environmental aspects.

The maintenance of the roads (55 000 km) is organized on the state level (The Centres of Administration and Maintenance of Motorways) and the regional level (The Centres of Administration and Maintenance of Roads). These organizations provide routine maintenance (including wintertime maintenance) while the construction maintenance and repairs are prevailingly carried out by the contractors.

The condition of roads and bridges is influenced with the lack of means for their maintenance. They suffered from the floods that distressed the Czech Republic in 1997, 1998 and 2002.

Increasing road traffic has become the main factor for the construction conditions since 1990. The traffic density is 50% higher for car traffic and 140% in the field of heavy vehicle transport. The high rate of heavy vehicle transport causes the failure of the road constructions.

In the Czech Republic, there is a sophisticated system to monitor roads conditions, evaluation of their serviceability, construction planning, maintenance and repairs of roads and motorways, project elaboration and their realization.

To evaluate the conditions of motorways and main roads serviceability, the ARAN, multifunctional measuring car, with SCRIM device and Deflectograph on the board is used. The data are processed by the Pavement Management System of the Road databank and serve as the base for maintenance planning and roads reconstruction.

The regional Centres of Administration and Maintenance of Roads use the Pavement Management System based on the visual inspection of roads with the deformation records. Optionally the California bearing ratio (CBR) assessment is carried out by Falling Weight Deflectometer.

The designs of the maintenance and repairs of the roads come from the road diagnostics consisting of failure records, determination of the causes of the failures including the measurement of CBR using Falling Weight Deflectometers, performance of the probes and laboratory assessments of various road layers materials. The design of the maintenance cannot be reduced or simplified; the cost of repairs performed incorrectly is higher than the savings of road diagnostics.

Progressive technologies known in advanced countries are used for road construction, maintenance and repairs. Considerable development has been reached in building lime treated soils technologies, usage of modified bitumen in wearing and binder coarses. Furthermore the use of the multigrade bitumen has been started. The construction of the concrete pavements has achieved a high level particularly the technology of two layers laying with reinforced joints; also recycling technologies for in situ realization has begun to be widely-used.

All the activities concerning condition assessment, projecting and construction of roads and motorways including laboratory tests are subject to the Quality System.

1. Organization and structure of the road administration

New administrative structure of the Czech Republic, division of the country in 13 regions and the capital of Prague, has influenced the organization of road administration. The state has retained the authority over 518 km of motorways and 6 091 km of the 1st class roads, which includes 2 644 km of European roads. The state by the means of the Ministry of Transport and The Directorate of the Roads and Motorways (ŘSD) ensures roads maintenance, repairs and reconstruction as well as the preparation and construction of new sections of motorways, highways and the 1st class roads.

The regions ensure the maintenance, repairs and the construction of 14 636 km of the 2nd class roads and 34 183 km of the 3rd class roads in their respective areas. The maintenance, repairs and the construction of 55 000 km of local roads is carried out by the respective towns and cities.

The Ministry of Transport administers general technical politics in the area, including the conception of the transport politics, provision of the standards and technical regulations and rules.

2. Main tendencies

The rapid increase of road traffic has become the main factor influencing the road administration. The following numbers show the situation the best – The number of heavy vehicles increased by 47,3% and cars by 55,8% in the period 1990 to 2000.

The average traffic density per 24hours increased by 50% on the motorways and the 1st class roads and by 25% on the 2nd class roads and the 3rd class roads in the same period. The transport capacity increased by 53%. Transport capacity proportion in % billion man-kilometer increased by 12% in the given period, in the heavy vehicle transport in % billion ton-kilometer even more than by 140% (to the loss of railway transport). The high level of heavy vehicle transport causes failures to the construction of roads.

The development of construction concentrates on finishing of the planned network of motorways and highways, on their interconnection with the neighbour countries infrastructure. The development of the 1st class road constructions is primarily motivated with the new regional structure, new industry areas, increase of road safety and environment protection. In this stage the communication with the public, road users and local authorities is very important; it proceeds in the preparation stages of the projects which emphasize the environmental aspect. Despite the agreement of regional authorities and the majority of people, “ecological organizations” obstruct the development of the territory.

Besides the construction it is necessary to ensure the maintenance of roads too. The Directorate of the Roads and Motorways (ŘSD) manages the maintenance of the motorways by the means of SSÚD (Administration and Maintenance Centres for Motorways) which maintain about 50 km of the motorway. The maintenance of the 1st class roads is realized by SÚS (Administration and Maintenance of Roads) under the contract. SÚS are authorized by the regions and their main activity is to manage and maintain the 2nd class and the 3rd class roads. SSÚD and SÚS carry out routine maintenance in particular. The construction, maintenance and repairs are made under public tenders in 90 % of the cases. The routine maintenance is predominantly performed in wintertime, the cost of the maintenance in winter makes 1/3 of the budget. The maintenance in winter is carried out on the motorways and 1st class roads in lines, on the other roads in circles. It is organized by ŘSD and the regional authorities. The central administration is ensured by ŘSD.

The discussion with the public about the road maintenance level is determined by the regulations and by allotted financial means. For example, the contemporary public requirements concerning wintertime maintenance are that the roads shall be not only passable for 24hours a day but shall be "black". According to the density of the traffic it means maximum use of preventive measures, which reflects in higher costs.

The requirements on road surface quality also exceed actual financial possibilities. The means for maintenance and repairs in the Czech Republic have been under-estimated for a long time. The budget to solve this problem represents less than 1% of the budget for the roads. The actual deficit makes almost 200 billion Czech crowns and it gets higher year by year. The floods caused much damage; in 1997 and 1998 they affected Moravia and Eastern Bohemia and caused the damages of 3,4 billion Czech crowns. In 2002 Bohemia was affected particularly and the damage is estimated to 5 billion Czech crowns.

Therefore it is necessary to use the maintenance budget wisely in accordance with the planning, make priorities with the use of PMS and HDM 4 and use progressive technologies.

The main resource to finance construction, repairs and maintenance of motorways and 1st class, 2nd class and 3rd class roads is the State Fund of Transport Infrastructure (SFDI). In addition to the afore-mentioned roads SDFI finance railway, air and naval infrastructure. The resource of the SFDI financial means originates partly from the fuel tax, motor vehicles tax, gains from motorway tax (labels), other fees and privatization contributions. The plan and the utilization of the SFDI budget is approved by the Parliament of the Czech Republic.

As the SFDI funds are not sufficient the means coming from the PHARE and ISPA funds and EIB loans are used.

In 2002 the Government of the Czech Republic approved a pilot project to construct a motorway using private financing. The contract has been signed with an Israeli company HOUSING AND CONSTRUCTION that is to assure the construction of 80 km motorway D47 and its maintenance for the future 30 years and the state will pay the instalments by the form of "shadow toll". After gaining some experience with private financing it is supposed to continue on other similar projects.

To achieve high quality of assessing the performance abilities of the road network and then planning new construction and maintenance it is necessary to fulfil a few indispensable long-term conditions.

3. State road databank

We have designed very good State Road Databank with about 15 years of data collection as information system based on three functions of data processing.

1. Data Processing and storage on efficient Internet and Ethernet built Server.
2. PC platform built Users Software of all parts of Road Information system like various PMS, Highway and Motorway performance monitoring system, Sign management systems, Bridge management systems, Accidents investigation and forensics, Road inventory and Intelligent traffic systems.
3. Full utilizing of all the data in GIS for the greatest number of potential users from other regions of interest like Environmental, Economical, Logistics and a lot of others.

These three functions are very useful as the investments into the information system are being returned.

Before we describe which data we collect in our Road Databank, we have to mention very important key feature of all road networks built databases, i.e. the exact Data Localization System. We use the "Nodal Localization System" and we hope it belongs to very accurate ones in the world. During the last few years of quick enhancing the GPS technology our state administration decided to build fixed skeleton of our Road Network System on physically stabilized and measured "Node points" with position accuracy 10 cm in GPS World co-ordinates system WGS84 (13 000 nodal points on road crossings and Region borders in average density 1 point per 2 km of network length of 21 000 km on motorways and 1st and 2nd class roads). The pavement axis between the nodal points is also measured and for each section the digital three dimensional trajectory with exact distance and all project parameters of Pavement Route is created. For users comfort we use digital video images "Right of Way" type of the network connected with this exact localization which is common for all data sources as backbone of the Road Information System.

Basic data stored in Road databank are

1. Data connected with localization system (co-ordinates, description and graphical layout of nodal point position plan for future renovation, connection of traffic directions in flyover multilane crossings).
2. Non-variable data:
   - description of Pavement (width of pavement, type of upper layer and all road inventory);
   - description of Crossings (type, shape, traffic directions, traffic regulations);
   - Registry of Road Objects (description of bridges, railroad crossings, viaducts and over-passes);
   - type of soil and pavement construction;
   - Geometry of Road Route (WGS co-ordinates of digital trajectory in 4m step, radius of curvatures, longitudinal and cross slopes, exact linear distances of all route shapes).
3. Time variable data measured by subsequently described diagnostics devices.
4. Registry of construction and maintenance activities.
5. Traffic engineering (traffic intensity and pavement efficiency).

4. Data collection – Diagnostics devices

We have been collecting all necessary data used for national multi-criterion PMSs that are deployed in our country for more than 6 years. The main time-variable parameters are measured on main road network every year and secondary road network was measured in a three-year period.

Data collection is carried out particularly by private subcontractors with the help of Road databank devices. The devices and subcontractors are very strictly assessed with emphasis on data true quality, international correlation, Worldwide international standards (ISO, ASTM, CEN) and the results of PIARC International Experiments.

Basic device for data collection of subcontracted deliveries is Canadian factory modular built multifunctional device ARAN used in 75 agencies in 15 countries. In our country ARAN provides information to support better management decisions by collecting consistent, accurate data quickly, safe and cost effectively. Wide variety of data are collected as:

Longitudinal profile/roughness (IRI), transverse profile/rutting, theoretical water depth in rutting, pavement condition and Road Databank Catalogue of pavement surface distress (15 types), pavement texture (MPD), cross-slope, GPS co-ordinates, panoramic digital right-of-way video with detailed surface image (tape or DVD disc), feature location. Czech subcontractor has been using ARAN in the Czech Republic for 10 years.

There are next two important parameters collected with different devices; California Bearing Capacity (CBR) and Skid resistance.

Bearing capacity is measured by private subcontractors who use a great number of devices based on Falling Weight Deflectometer system as Danish FWD Phønix PRI 100, FWD ML1000, DYNATEST FWD 8002, DYNATEST 8000 as well as device of Road databank DEFLECTOGRAPH DEF-03. These measurements are harnessed very intensively for Life Cycle Cost Analysis. The Directorate of the Roads and Motorways (ŘSD) prepares back-calculation software DG_LAYMED, which would be compatible with all FWD based device used in the Czech Republic.

Skid resistance was measured with Road Databank device SCRIM. The Czech device TRT is used especially on highways for special quality controls at high speeds up to 140km/h. This device is equipped with the system of 25% slip and accelerometer based roughness (IRI) measurement with video and GPS localization as well.

All mentioned data are processed in format of homogeneous sections in 5 degree scale evaluating parameter from very good to breakdown in structure enabling automated input to database system of various PMS.

5. National PMS

Sophisticated Expert PMS has been tuned for special national conditions (historical constructions, construction suppliers with their typical new constructions, climate, environmental needs and traffic specifics of central Europe etc.)

This system was developed in the beginning of the 90s and since 1996 has been ready for skilled use in 72 Road Administration Centres countrywide. It is maintained, filled with new data sets and upgraded with new modules every year. The MS Windows solution is prepared for next year upgrade with new modular budget module as well. This so-called Great Pavement Management System (GPMS), based on five parameters, is very similar to HDM 4 which is also used widely in the Czech Republic for global finance strategy studies requested by World Bank and European financial funds.

Our national GPMS is used for decision making concerning the maintenance planning and administrative activities at all levels of management on highways and 1st class roads network.

The goal of the system is to provide automated objective tool to make the planning of necessary pavement maintenance and repairs from year to year easier. Then multi- year planning is possible as well. It is based on middle and long term prediction with respect of Life Cycle Cost Analysis, financial year or multi-year planning and real state budget distribution. After such a step GPMS is used again; economical module and result of this automated processing are the priorities and case studies for next years network degradation and so necessary ongoing maintenance interventions.

The results and outputs of this system are

- 1-year maintenance plan with priority selection;
- 5-year economical prediction based strategic plan in three or four variants according to the budget amount with aspect to improve the network quality in any case;
- investments turn back calculation (income return percentage);
- degradation models of Life Cycle according to the measured parameters.

The architecture of the system is modularly designed for Three levels management

- Top management: Czech Road Directorate
- Middle: New Region Administrations
- Basic: District maintenance and administration centre

The Top management module enables to import data from Basic centre year plans and creates various scenarios depending on final year budget.

6. The construction of new pavements

It is necessary to mention new tendencies of the pavement designs and their realization because the construction and reconstruction of motorways and roads are in the focus of people's interest.

6.1 The design of the pavement

The design of the pavement is carried out according to the technical conditions, which are innovated for the use of performance related characteristics of road materials and pavement construction.

The design comes from the specification of pavement design reliability based on the distress probability that can be expressed as an expected percentage of deformed area caused by construction failures (deformations) after the design period of 25 years. The probability of deformation for motorways and important roads is determined as 1 %, for the other parts of the road network as 5 %. The probability of deformation is supposed to be even 25 % for roads with little density of the traffic or when the road technology of high frequency maintenance is used.

When proposing the most important characteristics are of heavy traffic, of a type of soil and its expected water content in a terrain and of used materials in the layers of a pavement. All the characteristics are based on field and laboratory measuring. The outputs of the measuring are the characteristics, which can be used when evaluating a pavement and the results.

The results of a flexible pavement come from the solution of multilayered elastic half-space. Rigid pavements are counted by finite elements methods. Counted tensile strains in pavement layers, compressive strains of subgrade and tensile stress in concrete slab are used to determine the number of loading repeatability.

To determine the number of loading repeatability the results of fatigue tests are used; it is expressed with Wöhler's diagrams and Miner's hypothesis of relative damage superposition.

The testing of pavement layers ensure its durability, resistance to permanent deformation and frost cracks.

The durability was only assessed at wearing courses with higher porosity than 10 %, but new trend is to assess all the wearing courses to specify the influence of water. The test of indirect tensile strength ratio of the test specimen is used after saturation and the influence of water to dry test specimen.

The wheel tracking test is to prove the characteristics of every mixture for wearing and binder courses used for heavy-trafficked or slow and often stopping traffic; the test is used with cycling pass of the test slab tempered in water of 50 °C by rubbered wheel.

The low-temperature characteristics are measured on testing beam fluently cooled by its velocity 10 °C per hour when avoiding its drying shrinkage. The incipient strength is measured straight as well as the modulus of stiffness, the change of length (it shall be null in average on three sensors) and the temperature at the time the specimen is ruptured. The low-temperature characteristics are to be proved only when using the type of bitumen with lower penetration than 65.

Particular results of the field and laboratory measuring on used materials for pavement construction can be used when counting results or assessing pavements; otherwise the materials characteristics are transfered on the basis of the materials composition. The system of the pavement design introduces checking mechanisms in various phases of the preparation period of a construction and within a construction period.

As an important element of the checking of pavement bases and unbound layers the checking of static load slab has been used. Specified values of the results come from the design of a particular pavement, from its soil characteristic, type and thickness of its capping layer and unbound layers. Pavement can be checked at the point of counting results and the performance of its layers and of the pavement construction by repeated force pulses of Falling Weight Deflectometer or passing the testing pavement.

The Czech Republic is situated in the climatic area where chemical de-icing agents are often used and so the pavement aeration of high quality is obligatory. The parameters of the freeze/thaw resistance are very strict; when proposing the pavement the maximum waste after 150 freeze/thaw cycles shall be 1 000 g/m^2 using the specified standard method.

6.2 The asphalt pavement construction

New tendencies have been used when constructing non-solid pavement in recent time.

The lime treated soils are often used; the construction rate, the work quality and the bearing ratio of the pavement have increased.

The modified bitumen is used in wearing and binder courses on heavy trafficked highways. Usually stone mastic asphalt is used in wearing course and asphalt concrete of 0/22 mm in binder course. Asphalt concrete of 0/11 mm is used for the other pavement and asphalt concrete of 0/8 mm is used for less trafficked roads. The usual thickness of asphalt concrete layers are 30 to 50 mm, but asphalt concrete layers of 20 to 30 mm are spread out. Some special thin layer asphalt concrete is used even on motorways. Porous asphalt is a subject of the research; it hasn't been supposed to use. There are some fears for preventive actions against ice-glazed pavement (using de-icing salts) and from airvoids clearing. The use of crumbled tire rubber added into a mixer is being verified with the system of dry mixing. The use of high stiffness modulus bitumen has been processed for subbases of heavy trafficked roads and motorways to increase the stiffness of asphalt layers and the resistance against fatigue.

The reducing of reflective cracking in a pavement with the use of concrete bound layers (soil stabilisation and aggregate bound with hydraulic road binder) is a subject of the actual interest. Various technologies are used when making joints between layers (sawing, trenches made at compaction) or contraction force release made by vibrating compactor when the layer gets stiffen. During the reconstruction the concrete pavement is usually broken in segments by breaker. The membranes of high-modified asphalt were also used. The use of reinforced net and grid is reduced only on covering repaired cracks, it is not recommended for pavement construction.

Industrial by-products are used at civil engineering work and pavement construction.

Reclaimed asphalt is added into asphalt mixtures, its amount is usually 10 % to 25 %. The asphalt plant can use almost 100% of R-material but it usually uses 70 %. R-material is used as an asphalt pavement base with thickness of 60 mm, without binders or it can be used in upper layers of a pavement with low traffic (the layer is to be formed). Reclaimed asphalt is put into a mixer together with a binder, cement – asphalt emulsion, with mineral aggregate.

R-material is obtained from breaking buildings. Fragmented and sieved masonry and concrete are used for earthwork and lower layers of a pavement with low traffic. Fragmented and sieved concrete, if the requirements on aggregate are fulfilled, is used for any layer of a pavement, it was used even in a wearing course.

Blast furnace and steel slag is treated in the regions with ironworks and steelworks. Slag is used in earthwork and pavement base, steel slag was used even in a wearing course (asphalt concrete, surface dressing and slurry seal). In the case the steel slag, which came directly from the production without being stored for a year, was used and the tests to find the change of slag's volume weren't made, the volume changes appeared and the pavement got some deformation.

Tailings are used for civil engineering work in the regions with coal and ore mining. When the tailings were used in a base of cement bound pavement some problems with swelling arose.

6.3 Concrete pavement construction

In the Czech Republic concrete pavement construction are carried out particularly on airfields, motorways, 1st class roads and areas for heavy load. Its use has been required in tunnels as a result of safety requirements in recent time.

6.3.1 Pavement base

The most common concrete pavement base used till 1995 was soil stabilization, which was replaced by cement bound base. In the base the grooves are carried out under future joints of concrete pavement. Nowadays, except the described base, mineral concrete is mechanically bound and so-called "thick slab"(30 cm) is put on. On airfields the porous asphalt was used except the described bases.

6.3.2 Actual concrete pavement construction

In 1995 the technology of so-called "simple slab" was replaced by two-layer technology of jointed reinforced concrete pavement; dowels in transverse joints (in the distance of 25 cm) and anchors in cross joints (3-5 within a slab). The usual thickness of the slab is 24-26 cm with exception of the already mentioned slab of 30 cm on unbound base. Concrete pavement is carried out by top two-layer technology with the "fresh to fresh" system, one-layer technology is used for smaller constructions. The width of concrete pavement laid as a whole (i.e. in one step) can be up to 15 m and usual daily performance of the finisher is 500 running metres. To achieve required regularity of the surface super smoother is always used. To reduce noise emissions the texture with towed jute is used and long-term satisfactory skid resistance characteristics of concrete pavement are reached using a quality aggregate with high coefficient of polishing. The maximum irregularity of pavement is 4 mm under 4 metre-long straightedge.

Contraction joints are sawed in hardened concrete perpendicularly in the distances of 5-6 metres, spatial joints are carried out in special cases – in the vicinity of the bridges or massive drainage elements. All the joints are filled with hot asphalt sealants or joint fillers (flexible rubber profiles).

7. Maintenance of pavements

Maintenance of pavements resulting into the assessment of the road network PMS is designed upon a project which is based on road diagnostics and design of a repair technology.

7.1 Road diagnostics and design of a repair technology

The design of road maintenance is made according to the technical conditions TP 87. The design is made on the basis of detailed diagnostics with the use of a detailed deformation record, FWD measuring assessment, cores, boreholes and laboratory analysis. On the basis of the results the technology of maintenance, repairs, recycling or pavement reconstruction are proposed.

TP 87 specify the values of measured pavement capability characteristics, which divide pavement condition into 5 classes. When the 4th class (insufficient) is recorded the maintenance or a repair of the pavement shall be planned. The characteristics are specified for all the measuring devices used for objective assessment of pavement capability:

- Skid resistance specified by friction tests – TRRL pendulum test, sand patch test, mean texture depth, friction coefficient measured by trailer with ABS system or blocked wheel or longitudinal friction test SCRIM.
- Longitudinal irregularity expressed by International Roughness Index, IRI or by levelling
- Rutting by straight edge or automatic record by special device (usually ARAN)

The assessment of pavement capability and condition can be carried out on the basis of type and volume of deformation. In deformation catalogue (TP 82) the cause and the development of all deformations are described and the deformations are drawn and their photos are taken. The example of a record and a deformation collecting carried out by computer, which is interconnected with a distance measuring device, is given together with graphics demonstration and deformed area assessment. The type and the volume of the deformations are assessed when the pavement is divided into sections and the sections are classified into the classification rank according to their capability or the maintenance necessity.

The design of road maintenance on the sections of the pavement other road diagnostics is carried out to determine the causes of the deformations and the design of various repair technologies. FWD processes bearing ratio measuring on construction deformations. Then the cores of asphalt mixtures and the boreholes to assess the pavement layers are carried out in the specific sites. The soil composition and water situation of the base can be evaluated. If these results are known then the design of the maintenance can be made effectively.

The design of the maintenance can be made without pavement assessment only by surface dressing or slurry seal. Wearing course repair requires for more the assessment of binder course, additionally subbase. The design of the recycling technology requires the design of the mixture with the use of the pavement materials in situ.

There are many examples, when imperfect or limited diagnostics led to the use of unsuitable technologies, short durability of the processed maintenance or a repair and the following repairs were much more expensive.

TP Design of maintenance and repair of flexible pavement are being innovated. After six-year use it is necessary to precise the rank of pavement capability characteristics and bearing ratio for pavement classification. The requirements were specified according to the pavement function PK with connection to the design reliability and the rank of traffic load. Except these characteristics of safety, economics and comfort aspects of the traffic it is necessary to distinguish pavements according to the used road materials for the pavement or wearing course construction. The distinction is particularly in the assessment of the condition of pavement with less durable wearing course and more frequent maintenance (surface dressing, slurry seal and penetration macadam) and block pavements. The precision of deformation characteristic values has been provoked by limited budget for low traffic pavement.

7.2 The repairs and reconstruction of concrete pavements

The process of maintenance, repair and reconstruction of concrete pavement can be specified as follows:

- regular innovation of joint fillers
- repairs of concrete disintegration of joints (in the vicinity of joints)
- repairs of folding steps on joints
- repairs of cracks, broken slabs and spatial disintegration
- reconstruction, substitution of cement concrete pavement in the sections of total concrete disintegration while the quality of base courses is kept
- Coverage of cement concrete coarse with asphalt layers

In the case of old and broken sections where local repairs would not be cost-effective the surface coarse reconstruction is designed by means of substitution of concrete slab in the full thickness, the base course is usually broken locally only. In most cases the soil stabilization does not show any failures after more than 30 years of exploitation.

The total reconstruction of cement concrete pavement where siliceous alkaline reaction occurred has been carried out in the recent time. The reconstruction is carried out part by part in the sections of one motorway and the old broken concrete pavement is substituted by the new one. Due to various reasons (enlargement of the pavement, concrete disintegration, the necessity of cross slope treatment…) some old cement concrete courses are covered with asphalt courses. The time will show whether the solution was right.

The design of the optimum pavement technology is carried out co-operatively with the project PK, which can impose other goals as elimination of pavement irregularities, elevation of pavement cross slope, spread of a pavement, correction of drainage, construction of cycling paths, pedestrian way etc. The co-operation between diagnostics and project makers is very important since the beginning of the project and for the time of diagnostics.

7.3 Maintenance technology

The most effective maintenance technology is in-time maintenance of a pavement at the creation of a deformation. The most frequent method to be used is Jet Patch device and Surface dressing by Road mending equipment (*PIARC expression, which corrected the expression Reparierenzeug in 1995*). The use of the device manages to prolong the durability of the pavement surface effectively. On the other hand the method is not suitable for heavy-trafficked roads and motorways; the potholes cannot be repaired, the irregularities of the surface get bigger and the durability is short.

The technology of overlaying and widening of pavements belong to the past. The lack of finance and materials is the cause and so the technology is replaced by pavement recycling in situ or by reconstruction.

The majority of hot and cold recycling technologies have been tested. The hot recycling technologies have not achieved a spread, because the asphalt mixture composition changes on short parts of pavements. The main problem on motorways and important roads is rutting, sometimes 180 mm of the depth. Such pavements are not suitable for hot recycling technology.

Cold recycling technology is considered to be a very good technology. The technologies with the use of cement and asphalt emulsions were used even by reconstruction of motorways. The main problem of its use on the secondary level of the road network is the use of macadam (aggregate 32/63 mm) in layer by layer pavement construction with the use of tar in the upper layers. Coarse aggregate is the cause the repair without sand addition or aggregate fragmentation is so difficult. Some pavements broke because of the lack of sand.

The most frequent repair technology is the milling of wearing courses, usually of the depth of 90 mm to 120 mm and positioning of new binder and wearing courses. The depth of milling is mostly determined by unsuitable mixtures, which had caused rutting (the upper courses used to be wearing courses – so they are of higher bitumen content). When using a binder course with higher porosity and higher content of coarse aggregate the course is often deformed because of lower bitumen content and bad adhesion of the bitumen to aggregate.

The significant Czech problem is the appearance of freeze and reflective cracks. The necessity of de-icing agents use in wintertime provokes the crazing of cracks as construction failure. When the milling and then the positioning are used the cracks are repaired by geotextiles reinforcement (geotextiles of glass fibre reinforcement). The minimum depth of geotextiles positioning is 100 mm under the pavement surface. The asphalt membrane covered by chippings, slurry seal or fibres is used for more frequent cracks.

Local repairs are carried out in a common way. To increase the comfort of driving and to improve the serviceability the old sections irregularities are milled on the joints with the size of the folds from approximately 4 mm, eventually slabs elevation with the size of the folds from 6 mm. As a new solution the repaired sections are doweled in the transverse joints of the slabs additionally, the irregularities of which were repaired by milling or elevation.

When carrying out the repairs, particularly on motorways, the reduction of traffic that causes in the time of rush hours, congestion and often increased number of accidents.

In these cases investor and property administrator take the following steps:

- mass media explicative campaign
- treatment and co-ordination of the schedule of road closures and traffic reduction
- choice of technology requiring the shortest time of realization
- priorities specification for the choice of suppliers taking in account the delivery periods
- specification of requirements concerning night work of the supplier
- specification of changing of lanes in the case of the closure of the road

Significant care shall be taken to road marking even though its costs may represent 20 % of the total sum. The public is informed of the road closures and traffic situation on the main roads by means of Internet and mass media.

8. Quality system

The Ministry of Transport announced the so called Sectional Quality System in the field of Road Construction in the middle of the 90s. Its goal is to increase the quality of construction, repairs and maintenance. The Quality System is based on standards – ČSN (Czech Standard) ISO, ČSN EN and others.

The Sectional Quality System covers six areas:

1. Project work
2. Survey (reconnaissance) and diagnostics
3. Testing and laboratory testing
4. Road and construction work
5. The other products
6. New technology implementation

The performance regimes are specified in details and described in the Methodic Guideline for each area. Technical requirements for construction products are regulated by the law and specified in the corresponding decree of the government.

The state investor represented by the Directorate of the Roads and Motorways (ŘSD) requires as one of the main documents for participation at public tenders the Quality System Certificate. The implementation of the Quality System and its certification are compulsory and necessary for the tenderer. Thus the contractor shall prove his adequate expertise for performance of the work.

As the investor has not implemented the Quality System yet its implementation should be the priority in the near future. Another deficiency is that the road and motorways administrators need not prove adequate expertise.

9. The rules and regulations

National regulations and recommendations are divided as follows:

-	legal:	Czech laws
-	administrative:	decrees of the government
		orders of the Ministry of Transport
-	economic:	general construction supply conditions – Ministry of Transport
		particular construction supply conditions – investor
		contract for work
-	technical:	standards – ČSN, ČSN ISO, ČSN EN
		technical and qualitative conditions (Ministry of Transport)
		technical conditions (Ministry of Transport)
		Catalogue of technical solutions (Ministry of Transport)

Concerning the standards the Czech Republic is a member of CEN therefore it is bound to comply with the requirements of European standards. The Project of European Standards Implementation in the field of Road Construction has already been set up and is financed mainly by The Ministry of Transport. A certain number of experts co-operating with the Czech Standard Institute and working groups and committees of CEN are involved in the project. The implementation of the European standards is a demanding process due to a different approach in standards preparation.

The Ministry of Transport issues its own regulations representing complex series of mutually interconnected documents.

Technical and qualitative conditions are the fundamental regulations covering the principles of technological procedures and technical parameters of the main construction technologies. They represent a complex of requirements concerning the realization, checking and work reception. They specify the qualitative requirements for material and finished work. They are an integral part of the contract.

Technical conditions are treated for a wide range of activities dealing with design, construction, maintenance, repairs and road facilities.

Catalogues of technical solutions containing construction rules and single details are also used.

The set of technical conditions and Catalogues of technical solutions are updated continuously on the basis of new and verified knowledge. They are prepared in accordance with the needs of the branch to reach unity, economics, quality and safety of the work and road construction. Comparing to ČSN EN the technical conditions enable quicker implementation of new knowledge into practice. They can be prepared in a more detail and more complex way.